

July 12, 2013 Rebuttal
Supplemental Expert Report of
Edward E. Leamer, Ph.D.

(Public - redacted under seal portions)

**IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF CALIFORNIA
SAN JOSE DIVISION**

**CONFIDENTIAL – TO BE FILED UNDER SEAL
SUBJECT TO PROTECTIVE ORDER**

**IN RE: HIGH-TECH EMPLOYEES ANTITRUST
LITIGATION**

No. 11-CV-2509-LHK

THIS DOCUMENT RELATES TO:

ALL ACTIONS

REBUTTAL SUPPLEMENTAL EXPERT REPORT OF EDWARD E. LEAMER, PH.D.

July 12, 2013

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I. Introduction, Assignment, and Summary of Conclusions

1. I have been asked by the Plaintiffs to comment on the Supplemental Report of Dr. Kevin M. Murphy dated June 21, 2013 (“Murphy Supplemental Report”), and in particular to say whether any of the opinions expressed by Dr. Murphy cause me to change the conclusion reached in my Supplemental Report dated May 10, 2013 (“Leamer Supplemental Report”), that the alleged restraint of competition by the Defendant firms suppressed compensation to all or nearly all members of the proposed Technical Class. They do not. Exhibit 1 lists materials I have relied upon in addition to the materials cited in my previous reports.

A. My Opinions

2. Dr. Murphy has distorted my opinions, and to set the record straight I offer a summary in this section.
3. The hypothesis that underlies my study of the defendants’ payroll records is that the non-compete agreements prevented a burst of actual cold calls from happening and also eliminated the threat of future cold calls between the agreeing parties. I have never offered the opinion that the effect of a single isolated cold call would necessarily increase compensation for every employee in the Technical Class. My opinion is that the information conveyed by each cold call reinforces the information in other cold calls, making the effects “superadditive”, meaning that the effect of a burst of cold calls is more than the sum of the parts. My opinion is that, absent these illegal agreements, bursts of cold calls and a heightened threat of cold calls would have been met with increases in compensation for all or almost all individuals in the Technical Class.
4. Cold calls that were suppressed by the non-compete agreements were likely more concentrated in some titles than in others. I also have the opinion that the firms’ assessments of the *threat* of cold calls—and their responses to those threats—would have been broader than just the cold calls that actually would have happened in the but-for world. Because the cold calls in the but-for world would have been more concentrated in some titles than in others, and because any broad response to the burst of actual cold calls and the threat of future cold

calls would have occurred through Defendants' title-based pay systems, I have chosen to use the title averages as the basis for my data work to help define the class. In addition, title averages tend to be less affected by the idiosyncratic individual variability which is irrelevant to a finding of common impact throughout the Technical Class.

5. As a measure of the tightness of the ties that bind titles together, I have reported correlations of both the levels of compensation and the percent changes in compensation of each title vis-à-vis the rest of the firm's Technical Class absent the title in question.¹ My opinion is that this correlation evidence supports and is supported by the abundance of documents and testimony that reveal the importance of internal equity issues for firms generally and for these firms in particular.
6. Correlations need not be solely the consequence of internal equity concerns that work to tie compensation together, but may also arise partly from other factors that are common across titles. I have therefore controlled for what I regard to be the two most powerful common forces—firm performance (measured by firm revenue) and external market forces (measured by the employment levels in the San Jose MSA). In the estimated model that I have presented, these forces have different impacts on the various titles but these forces do not explain away the substantial correlation between title compensation and the firm's overall Technical Class compensation.

B. Dr. Murphy's Opinions and My Specific Responses

7. In his Supplemental Report, Dr. Murphy presents the following opinions:²
 - a. Dr. Murphy claims my analysis must, but cannot, demonstrate that "a raise to employees who receive a cold call would increase compensation even to other employees with the same job title."

RESPONSE: This comment refers to the effect of a single cold call,

¹ Leamer Supplemental Report, pp. 10-12.

² Murphy Supplemental Report, pp. 1-2.

not to the relevant hypothetical: bursts of cold calls and a heightened threat of future cold calls.

- b. Dr. Murphy claims “correlations of average compensation by job title with overall average compensation for the proposed Technical Class cannot show that raises for some employees necessarily would result in raises for some or all.”

RESPONSE: This also refers to the wrong hypothetical. For the relevant hypothetical of bursts of cold calls and elevated threats of cold calls, correlations of compensation, correlations of changes in compensation, and the contemporaneous and inter-temporal relationships in compensation across the proposed Class all strongly support the conclusion that Defendants’ compensation is structured such that it would make the impact of the non-compete agreements common to the proposed Class.

- c. Dr. Murphy claims that “neither [my] correlation analysis nor [my] regression analysis can distinguish a ‘somewhat rigid’ compensation structure” because they fall “victim” to two well-known statistical fallacies and that these fallacies “virtually guarantee” my sharing regression results.

RESPONSE: The “reflection” and “regression-to-the mean” fallacies do not apply to my work. The first fallacy amounts to the familiar statement that correlation is not causation, but I have never claimed otherwise. It also amounts to the familiar generic fact that estimated regression models change when additional variables are added into the equation. I am fully aware of this fact, and the reason I added additional variables into my correlation analysis is to determine the extent to which the observed correlations are due to two potentially important common factors. Dr. Murphy, rather than being helpful, merely states what is obvious: that there theoretically might be other variables one could study. If that were all that is necessary to invalidate a regression, no one could ever estimate a regression with non-experimental data. The second, “regression-to-the-mean,” fallacy depends on the presence of substantial randomness in the data set; Defendants do not pay their employees in a substantially random way.

- d. Dr. Murphy claims that I do not “establish that the proposed class is properly defined.”

RESPONSE: I have provided evidence that supports the proposed class. Dr. Murphy has provided no evidence useful for an alternative definition of the boundaries of the class.

- e. Dr. Murphy implies that I needed to “improve the accuracy” of the conduct regression.

RESPONSE: My conduct regression demonstrates a reliable methodology capable of measuring damages on a class-wide basis. The regression model I proposed utilizes the variation in the data and is accurate enough to distinguish impact year-by-year and defendant-by-defendant.

C. Summary of My Responses

8. Dr. Murphy’s first four arguments boil down to claims that 1) the presence of substantial individual effects implies that there cannot be a common firm-wide internal equity component to compensation, and 2) the statistical evidence that I find of the importance of internal equity and sharing as a common factor in compensation is the result of something else—either some other common factor(s) he fails to identify or a statistical anomaly. I discuss his final issue regarding my conduct regressions below.
9. There are certain similarities in how Dr. Murphy and I view Defendants’ compensation setting and important differences:
 - a. Dr. Murphy and I both agree that there are individualized factors in individual compensation (though he exaggerates their importance and downplays the extent to which Defendants take a systematic approach to adjusting compensation in response to those individualized factors within their firm-wide compensation structures);
 - b. Dr. Murphy and I both agree that market factors play a role in compensation. It is for this very reason that I included market factors in my sharing regressions to control for these effects; and

- c. Dr. Murphy and I both agree that there may be common factors within the firm—not related to the non-compete agreements—that may influence employee compensation. Firm performance is probably the most important common factor and the only one identified by Dr. Murphy. I included firm revenue to control for such effects. While Dr. Murphy is silent about what other factors may tie firm-wide employee compensation together, the statistical, theoretical and documentary evidence I have presented establishes that internal equity and the use of a salary structure by these firms is also an important factor.
- 10. In this Report, I address Dr. Murphy's claims. **First**, I point out that Dr. Murphy incorrectly focuses on the reaction that firms make to *individual isolated* cold calls, and he ignores the response that firms make to bursts of cold calls. He also ignores the broad preemptive responses that firms make to the threat of cold calls, for example, the across-the-board increase in base salaries for Google employees in 2011.
- 11. **Second**, Dr. Murphy incorrectly acts as if the data evidence has to stand on its own in determining the class.³ Wise interpretation of non-experimental data needs to be sensitive to the context in which the data were generated, and persuasive conclusions from the numerical data require the information in the numerical data and the documents to be aligned. The data in this case support and are supported by substantial documentary and testimonial evidence including but not limited to the following:
 - a. The non-compete agreements covered *all* employees in the defendant firms;
 - b. The CEOs of the defendant firms confirmed the broad and substantial impact that the cold calling was likely to have had by the fact that they personally got involved in these illegal agreements;
 - c. HR documents of all these firms confirm the importance of internal equity in the setting of compensation levels;

³ Deposition of Kevin Murphy Vol. 2, July 5, 2013 at p.443:12-14, "The court can read the documents. I'm an economist. I got no particular advantage of reading documents."

- d. Depositions of HR professionals within these organizations also confirm the importance of internal equity; and
 - e. There is substantial literature in economics which Dr. Murphy ignores regarding the importance of internal equity in the compensation setting, brought forward by my previous reports and Dr. Hallock.⁴
12. Only by incorrectly focusing on the impact of individual isolated cold calls and by incorrectly ignoring the substantial documentary and testimonial evidence is Dr. Murphy able to issue the challenge that I have not shown the causal chain linking a cold call to compensation of the recipient and to anyone else. This challenge is only marginally relevant for the bursts of cold calls prevented by the agreements and irrelevant for the preemptive compensation increases that firms can make to prevent cold calls from happening and to mitigate the damage that attractive cold calls might cause. In neither case is the impact spread through the firm per the causal chain to which Dr. Murphy refers.
 13. Moreover, a direct causal inference such as the one alluded to by Dr. Murphy requires experimental evidence like a clinical trial in which the treatment is randomized, but as Dr. Murphy surely knows, there is nothing like that in this data set. Accordingly, we analyze correlations, which are routinely used by economists to draw causal conclusions when supported by compelling frameworks and complementary information. The fact that all or almost all of the titles are tied closely together is evidence that the impact of the agreements would spread at least throughout the Technical Class.
 14. **Third**, the fallacies that Dr. Murphy identifies simply do not apply to this context. First, I anticipated and addressed the potential “reflection problem” by analyzing correlations between non-overlapping sets of employees. I used these correlations to assess whether these titles have compensation levels that are tied together, and in the face of competitive pressure they are likely to remain tied together. Second, I reject Dr. Murphy’s notion that compensation is subject to the same kind of randomness as the daily weather in Chicago. For that reason, Dr. Murphy’s concerns about “regression toward the mean” are unjustified by

⁴ Expert Witness Report of Kevin F. Hallock, May 10, 2013 (“Hallock Report”).

the circumstances and not connected to any factual evidence that describes how these firms chose compensation levels. Employee compensation is the outcome of a deliberate decision making process followed by the firms and is not subject to the degree of randomness that Dr. Murphy suggests.

15. **Fourth**, Dr. Murphy again emphasizes that left-out variables can cause problems with regression analysis. However, he has not put forward any specific example of such an effect. This argument remains entirely hypothetical and entirely unconvincing. While I have controlled for the external and internal non-sharing effects that he claims pollute my results, he has not presented *any* evidence showing that omitted non-sharing external or internal effects are actually responsible for the positive sharing in my results. He has not elaborated on what his claimed ‘other common factors’ could be. Nor has he proposed any test of whether my results are flawed.
16. To further suggest the existence of omitted variables, Dr. Murphy also uses data on U.S. compensation by occupation collected by the American Community Survey. It is evident that Dr. Murphy has not seriously studied these ACS data and presumes that his cursory look is enough. In the brief period of time I have had to review this work, I have uncovered numerous serious errors both with the data and with the way they have been (mis-)interpreted by Dr. Murphy. The ACS-based work of Dr. Murphy is irrelevant and unreliable.
17. **Fifth**, the conduct regressions in my Report and Reply Report illustrate a method of computing damages for the Technical Class and are capable of providing reliable estimates of Defendants’ under-compensation of their employees.

II. Dr. Murphy Considers Only Isolated Individual Cold Calls, and Ignores the Effects of Bursts of Cold Calls and Heightened Threats of Future Cold Calls That Would Have Occurred Absent the Illegal Agreements

18. Dr. Murphy proposes that all impact begins with individuals who would have been cold-called but-for the non-compete agreement. He insists on proof of a causal chain linking other employees to the ones that would have had a cold call. This theory is a strictly reactive theory, i.e., any compensation-setting reaction

by management is in response to a specific cold call. This view is clearly stated by Dr. Murphy [emphasis added]:

8. Dr. Leamer's empirical analysis focuses on whether changes in average compensation for various job titles are correlated with movements in the average compensation level for the proposed class as a whole. **He does not examine whether changes in compensation at the individual level, which is where the initial impact of any cold call would occur, necessarily cause changes in compensation for all or nearly all employees in the same job title or for the proposed class as a whole.**⁵

19. And:

22. [...] Even if, as Dr. Leamer claims, a "Large Share of [Job Title] Change Correlations are Positive," it does not follow that Defendants have compensation structures that require them to change compensation for all, or nearly all, class members if they raise one employee's compensation in response to a cold call.⁶


20. This theory of Dr. Murphy's presumes incorrectly that the impact of cold calls is additive, as if a burst of 1,000 cold calls were equivalent to 1,000 times the effect of a single isolated cold call. On the contrary, the information in one call would tend to reinforce the information in others, and the effect is consequently likely to grow rapidly with the number of calls (or to use Dr. Murphy's preferred term, "super-additive"). Given this aspect of the cold-call effects, it is my opinion that the high degree of historical co-movement in compensation across titles supports the conclusion that the response of these firms to a burst of cold calls would have spread at least to the edge of the Technical Class.

⁵ Murphy Supplemental Report, ¶ 8.

⁶ Murphy Supplemental Report, ¶ 22.

21. Another avenue for the effect of the agreements—and perhaps the most important one—is their disruption of proactive strategies in response to cold calls. By completely eliminating the threat of cold calls between the agreeing parties, the agreements also completely eliminated the need for management to make a preemptive response. *The greatest error of Dr. Murphy's response is that he ignores completely the avenue of effect through preemptive responses to threatened cold calls in the form of broad increases in compensation intended both to suppress the cold calling rate and to make the cold calls that nonetheless occur relatively unimportant.*
22. For studying the case of preemptive responses to threatened cold calls, the job of the analyst is not to trace out the impact of cold calls from individual to individual or from title to title but instead to identify the sets of individuals that management would likely include for preemptive increases in compensation. These preemptive responses apply not just to those workers who are experiencing increased external competition but also to all the others who would be included because of internal equity considerations. The historical correlations help to identify the subset of titles that would likely be excluded – those titles that historically had compensation levels that were unconnected with the rest of the firm.
23. My theory of damages includes the reaction to a burst of cold calls and also the *broad preemptive* responses that management would make to the threat of cold calls.⁷ There is substantial evidence in this case for the occurrence and importance of these types of responses. Some examples already offered by Dr. Hallock are:

[Intuit]



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[Google] “We should look internally and review the attrition rate for the SRE group. We may want to

⁷ Leamer Supplemental Report, ¶ 15.

⁸ Deposition of Mason Stubblefield, Intuit, March 29, 2013 at p. 70.

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consider additional retention incentives or team incentives to keep attrition as low as possible in SRE.”⁹

Regarding Lucasfilm’s use of compensation surveys as benchmarks:

“The [REDACTED] [percentile], again, like I said, depending on the industry circumstance, sometimes was in the — sometimes it was the [REDACTED] for critical talent, and when economic conditions didn’t need it, it came back down to the [REDACTED].”¹⁰

[REDACTED]

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[Intel] Q. Well, in Intel’s consideration of its compensation system or adjustments to its compensation system, for example, through the focal process or some other process, did Intel ever raise compensation for particular job categories or job ranges to preemptively prevent attrition? A. [REDACTED]

[REDACTED]

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⁹ GOOGLE-HIGH-TECH-00379327-330, exhibit 614, email from Arnon Geshuri on Saturday March 15, 2008.

¹⁰ LUCAS00188913 (Exhibit 711.29) for 2008 and LUCAS00188912 (exhibit 360) for 2006.

¹¹ Deposition of Stephanie Sheehy, March 5, 2013 at p. 106.

¹² Deposition of Patricia Murray, Intel, February 14, 2013 at pp. 181-182.

24. Preemptive adjustments are intended to minimize the damage that attractive cold calls might cause to the behavior of not just the individuals who (in the but-for world) would have been cold-called—but also the broad swath of employees whose loyalty might be diminished by knowledge of better opportunities via cold calls received by their colleagues.
25. In an earlier report, Dr. Murphy pointed out that the amount of movement between the Defendants was never very great in any of the years for which Defendants have provided payroll records, and he has used that as an argument that the agreements could not have had much effect.¹³ However, the fact that the CEOs of these firms got involved in this non-compete scheme means that the cold calls prevented by the agreements potentially had serious systemic effects even if there wasn't much movement of employees. The CEOs who formed these agreements must have expected that the impact was not just through the loss of an individual employee or two consequent to a cold call but through the broad increased threat of movement and the reduced worker loyalty that can be created by knowledge of better opportunities elsewhere.¹⁴

III. Contrary to Dr. Murphy's Opinion, the Presence of Individual Effects, Even Large Ones, Leaves Room for Common Factors Affecting All

26. Dr. Murphy's first opinion is:

The variation in individual compensation, which Dr. Leamer's analyses ignore, shows that a raise for one or some does not necessarily cause a raise for all or nearly all.¹⁵

¹³ Murphy Report, pp. 18-20, and Leamer Reply Report, pp. 11-13.

¹⁴ As Pixar's President Ed Catmull observed in an email to a Disney executive: "Every time a studio tries to grow rapidly, it seriously messes up the pay structure . . . by offering higher salaries to grow at the rate they desire, people will hear about it and leave." PIX00000229.

¹⁵ Murphy Supplemental Report, p. 2.

27. This view is completely off-point. To determine whether the employees in the proposed Technical Class were harmed by the non-compete agreements, I do not have to demonstrate (nor do I believe) that a “raise for one or some does necessarily cause a raise for all or nearly all.” My opinion is that the documents and the data support the conclusion that the response to the bursts of cold calls prevented by the agreements and the response to the threat of cold calls prevented by the agreements would together have had effects that extended throughout the proposed Technical Class, increasing compensation in the but-for world for all or almost all of the proposed class members. The reason for this is that both the response to bursts of cold calls and, even more, the response to the threat of cold calls would surely raise internal equity concerns that would spread the impact to the edge of the class.
28. My work is based on the assumption that there are individual effects in compensation and there are also common firm-wide effects that tend to tie the individuals together. My opinion is that the class should include (1) all individuals who were in the group of probable recipients of the burst of cold calls, and (2) all who were in the group of individuals who would have experienced heightened risk of cold calls and also (3) those individuals who are linked to the first two groups by internal equity considerations.
29. The payroll data that I have studied cannot be used to identify the first two affected groups, but the written record indicates that these individuals are very likely concentrated inside the Technical Class. It is possible that the increased cold calls and heightened threat of cold calls extended very broadly, affecting all or almost all members of the Technical Class, but I do not rely on that possibility. What I rely on is that the forces of internal equity are very broad and likely to extend the impact of the anti-cold-calling agreements to all or almost all members of the Technical Class. The statistical task is to identify the common factors in the individual data and to apportion these common factors between internal and external forces.
30. As I explained in my report, one of the reasons that I chose to work with title-based averages is that averaging across the individuals in any title can reduce the

individual idiosyncratic effects and make the common factors more evident.¹⁶ The other reason for using a title-based data set is that it is the title structure that allows senior management to control compensation throughout the firm. The right class definition consequently should be title-based, and I have explored the technical-class titles to determine if there are any titles with average compensation packages that are not tied internally to compensation packages in other titles. I have not found any titles that are immune to the forces of internal equity and that should be excluded from the class. Dr. Murphy has not made any attempt to argue that any titles should be excluded.

1. Defendants' Use of Salary Range Targets is Consistent with My Title-Focused Analysis

31. This approach is supported by Defendants' use of target salary ranges in determining their employees' base compensation. As shown in Appendix A, the target salary range data¹⁷ matched with their payroll data indicates that Defendants conformed their employees' compensation to those ranges 97 percent of the time (employee-years for which data were available).

2. Google's Big Bang Demonstrates that Dr. Murphy's Individual-Level Approach Hides Common Impact

32. Dr. Murphy claims that the search for impact should begin at the level of individual compensation. A closer look at the Google data, including the 10 percent across-the-board increase that occurred on January 1, 2011, illustrates why the title is an appropriate level of aggregation for this analysis: the inherent noise in the individual level data tends to drown out the signal of the internal pay structure we are trying to detect. I will demonstrate here that individual variation in the data masks even such a sweeping common phenomenon as the Google Big Bang, which we know occurred. An analyst working with this data will do much better justice to such common phenomena by studying the titles as opposed to the individual employees.

¹⁶ Leamer Supplemental Report, p. 6.

¹⁷ This analysis is based upon salary range data produced by Adobe, Apple, Google, and Intel. Intuit did not produce adequate data, and thus was not included in this study.

33. Table 1 reports summary statistics for year-by-year percent increase in base compensation for Google's employees in the Technical Class. These include the mean, or average, increase in base compensation and the standard deviation, a measure of the variability in that increase across Technical Class employees. According to Dr. Murphy's theory that making a company-wide change in pay largely precludes individual variation, he would apparently expect something like a 10 percent mean and a 0 standard deviation for the percent change in base salary for the period that includes January 1, 2011 (December 31, 2010 to December 31, 2011). This would indicate that all effects are common effects and there are no individual effects. However, the mean for the year 2011 is [REDACTED] percent, much larger than [REDACTED] percent, and the standard deviation is [REDACTED] percent. The standard deviation in 2011 is similar in size to all the other years, and usually exceeds the mean. This demonstrates that there was very substantial individual variation in all years, even 2011 - the year in which we know there was a large common factor.
34. Table 2 provides the same information about total compensation, which also shows variability even in the year 2011 in which we know there was a common factor affecting compensation. Hence, the presence of individual variation, such as seen in Table 2 and emphasized by Dr. Murphy, is entirely consistent with common impact.

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Table 1
Google Base Salary Increase
Technical Class Employees with Google for the last Two Years

<u>Year</u>	<u>Mean</u>	<u>Median</u>	<u>Max</u>	<u>Min</u>	<u>Std. Dev</u>	<u>Obs.</u>
2002						
2003						
2004						
2005						
2006						
2007						
2008						
2009						
2010						
2011						
All						

Source: Google Employee Compensation Data

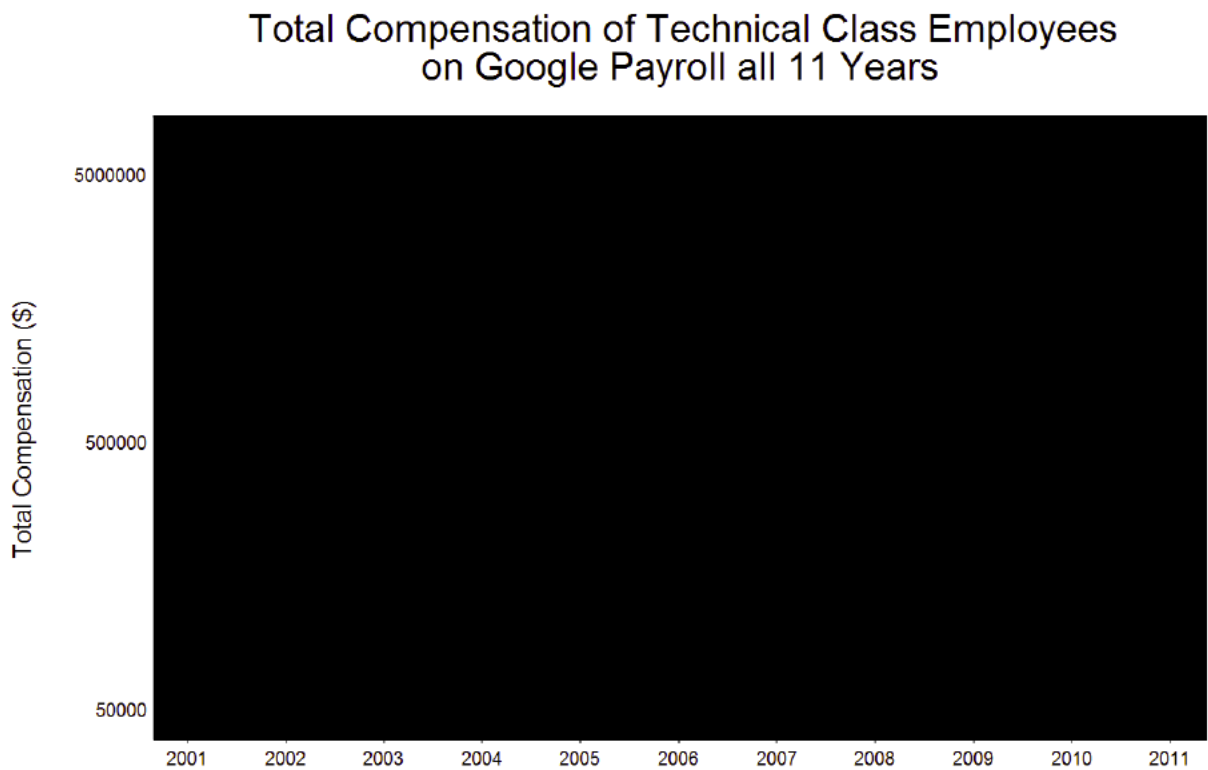
Table 2
Google Total Compensation Increase
Technical Class Employees with Google for the last Two Years

<u>Year</u>	<u>Mean</u>	<u>Median</u>	<u>Max</u>	<u>Min</u>	<u>Std. Dev</u>	<u>Obs.</u>
2002						
2003						
2004						
2005						
2006						
2007						
2008						
2009						
2010						
2011						
All						

Source: Google Employee Compensation Data

35. A simple chart shows how individual-level data can be used to obscure an event with known common impact. Figure 1 illustrates total compensation for the individuals who were Google employees in all eleven years. The Big Bang seems entirely disguised in the individual data in Figure 1. Therefore, somebody who is entirely focused on the individual data would miss the occurrence of the 2011 event.

Figure 1: Individual Total Compensation for Employees on Google Payrolls all Eleven Years



Source: Google Employee Compensation Data
Note: Technical Class Employees who had been at Google for all 11 years. Log scale used.

IV. Dr. Murphy's Claims about Statistical Errors are False

36. Dr. Murphy incorrectly claims that I confuse correlation and causation. In Section IV of Dr. Murphy's report he describes the "reflection problem" and

“reversion toward the mean.” His claims are false and my work does not suffer from either of these problems.

A. Correlations are Informative

37. Dr. Murphy’s second opinion is a repeat of the familiar statement that “correlation is not causation.”

In the language of economics, Dr. Leamer implies that his correlations reflect causality – that a change in one variable leads to or causes a change in the other – but he then offers only evidence of co-movement. However, correlation, or similar movement, in average job-title compensation does not establish the necessary causation to support Dr. Leamer’s theory.¹⁸

38. Correlations are an accepted part of the scientific enterprise in economics and economists routinely study them in pursuit of knowledge. For example, a textbook cited by Dr. Murphy describes correlation as a “measure... of the strength of a relationship between two random variables.”¹⁹ Moreover, in a published article, Dr. Murphy uses correlation analysis to establish a “strong link between... crack [cocaine] and increased homicide rates by the young.”²⁰ This article also makes use of a simple regression formulation despite recognizing that “[i]t is possible that omitted variables... affects both crack and outcomes like homicide.” In this same article Dr. Murphy and his co-authors use aggregation which “increases the signal-to-noise” ratio in a fashion similar to my averaging across individuals to reduce the noise in individual compensation.²¹

¹⁸ Murphy Supplemental Report, ¶ 21.

¹⁹ Casella G. and R. L. Berger, *Statistical Inference*, Cengage Learning; Second Edition (June 18, 2001), p. 169.

²⁰ Fryer, R. G., P. S. Heaton, S. D. Levitt and K. M. Murphy, “Measuring crack cocaine and its impact,” *Economic Inquiry*, Vol. 51, No. 3, (July 2013), pp.1651-1681.

²¹ “[B]ecause each of our individual proxy measures is quite noisy, combining them into a single index substantially increases the signal-to-noise ratio” Fryer, R. G., P. S. Heaton, S. D. Levitt and K. M. Murphy, “Measuring crack cocaine and its impact,” *Economic Inquiry*, Vol. 51, No. 3, (July 2013), pp.1651-1681.

39. Absent experimental evidence, what we have to rely on are simple correlations and regressions (“partial” correlations which hold fixed other potentially important confounding effects). I have provided both.

B. There is No “Reflection Problem” in My Analysis

40. Dr. Murphy uses Professor Manski’s somewhat vague definition of what he calls the “reflection problem” which is: “This identification problem arises because mean [average] behavior in the group is itself determined by the behavior of group members. Hence, data on outcomes do not reveal whether group behavior actually affects individual behavior, or group behavior is simply the aggregation of individual behaviors.”²² I have to some extent anticipated this issue by comparing compensation in each title, not simply with the Technical Class overall, but with the Technical Class overall with all the individuals in the title removed. This means I am comparing completely non-overlapping sets of individuals in each of my regressions.
41. Still, there remains an issue regarding direction of causation which would more accurately be described as a “simultaneity problem.” As an illustration, consider the compensation of just two distinct individuals. Here there is no Manki-type average group behavior to worry about and there is no way to use the correlation between A and B to distinguish the possibility that A affects B, or B affects A, or some outside force “causes” both A and B.
42. Correlations are informative regardless of the direction of causation, especially for the preemptive theory in which the issue is whether titles are “tied together.” However, even for causation, as Manski suggests,²³ it is possible to use lagged values to see if A data tend to be followed by similar B data. A temporal ordering such as A routinely preceding B is known as “Granger causality.”²⁴ As

²² Murphy Supplemental Report, ¶ 35.

²³ “One alternative supposes that the researcher observes the dynamics of a process in which individual behavior varies with lagged rather than contemporaneous values of group mean behavior.” Manski, C. F., “Economic Analysis of Social Interactions,” *Journal of Economic Perspectives*, Vol. 14, No. 3 (Summer 2000), pp. 115-136.

²⁴ Enders, W., *Applied Econometric Time Series*, Hoboken: John Wiley & Sons, Inc., Third Edition (2010), pp.

the adjective suggests, this is an indication of causality (though not definitively). That is why I have used the lagged value of the title compensation compared with the rest-of-firm compensation to determine if departures of the title compensation from the normal relationship with compensation in the rest of the firm tend to predict corrective action – and I find that they do.

43. After quoting Manski regarding group behavior, Dr. Murphy diverts to the familiar left-out variable problem (which is different from the simultaneity problem): “Generally, when individuals in a group are subject to at least some common influences, it will appear that they are responding to each other even when they are not.”²⁵ That is exactly the reason in my deposition I agreed that the high degree of co-movement of compensation title-by-title could hypothetically be coming from external market forces, although this seems highly unlikely.²⁶ Hence, I have added two new variables that might be able to explain fully the intra-firm correlations. I chose variables to include in my model that measure what I regarded to be the two most promising explanations for the co-movement of title compensation: (1) revenue sharing, meaning that variability in firm revenue that was shared broadly with the workforce and (2) external market forces, which could affect more than one title at the same time.

C. Dr. Murphy’s Theory of Regression toward the Mean Requires Randomness That Is Not Part of the Compensation Determination in the Technical Class

44. Dr. Murphy has made a reference to “regression toward the mean” as a way of dismissing my result that there is a lagged corrective effect measured by the ratio of the firm’s Technical Class average compensation (excluding a title) and the title’s average compensation, lagged one year. Regression toward the mean refers to sequences of repeated random draws from the same population, and thus the tendency for a draw that is abnormally high to be followed by something closer to the mean – thus regression toward the mean. Per Dr.

318-319.

²⁵ Murphy Supplemental Report, ¶ 35.

²⁶ Deposition of Edward Leamer Vol. 2, June 11, 2013 at pp. 528:7-16.

Murphy, “[t]he regression fallacy arises when an analyst examines a data series that is subject to shocks that are, at least to some extent, temporary, and ignores the tendency of such data to “regress” or revert to the mean of the distribution.”²⁷

45. The applicability of regression toward the mean to payroll records of Defendants seems to me extremely doubtful. Defendants do not set annual title compensation the way that Mother Nature chooses Chicago weather, day-by-day. Compensation levels in the Technical Class are all determined thoughtfully by management, not by random devices.
46. The only example that Dr. Murphy provides is salespeople on commission. For salespeople the regression toward the mean phenomenon may arguably have some validity. But absent the evidence, I am not so sure that annual compensation even for salespeople exhibits regression toward the mean. Day-by-day randomness could be there, but averaged out over 365 days we may be getting mostly constant ability and variable external market sales opportunities.
47. But, in any case, there are no salespeople in the Technical Class. They have been excluded as indicated in Exhibit B of my October 1, 2012, report. Nor are there any employees who are paid based on random factors. Firm revenue to some extent may behave like a random variable, and some titles may share in revenues more than others, but I have included the firm revenue as a variable which should soak up that effect.
48. In sum, Dr. Murphy has produced a purely hypothetical claim about regression toward the mean which relies on an implausible firm approach to compensation setting.²⁸

²⁷ Murphy Supplemental Report, ¶ 45.

²⁸ On the other hand, as I discuss below, randomness in reported compensation is likely an important issue in the data collected by the American Community Survey (ACS) that Dr. Murphy used.

D. Dr. Murphy's Study of Chicago Daily Temperature is Flawed and Irrelevant

49. Dr. Murphy's temperature regression model that seeks to explain Chicago temperature changes is another example of an analysis designed to illustrate an intended result. Chicago and Milwaukee are within two hours driving distance, so in the absence of any reasonable control variables, it should not be surprising that the regression shows a high degree of association. It would be a surprising result only if it were true for several far apart cities in totally different climate zones and it persisted even after using adequate control variables.

V. Dr. Murphy's Analysis of "Sharing" in the ACS Data is Flawed and Unreliable

50. Dr. Murphy mindlessly applies my analysis of co-movement to the economy-wide American Community Survey ("ACS") compensation data collected by the U.S. Census Bureau. Dr. Murphy uses this analysis to support his claim that the analysis I performed would indicate relationships even where none existed. There is no support in Dr. Murphy's work for this conclusion. There are important measurement error and reliability problems with the ACS data that render it inappropriate for the time series analysis that Dr. Murphy has performed. Additional and equally compelling methodological problems with his work are set forth below.
51. Beyond the issue of measurement problems the basic premise of this work is mistaken. Although Dr. Murphy claims that discovery of co-movement in his ACS analysis reflects a statistical anomaly that would infect any analysis of the type I have done, some co-movement due to market forces can be expected as individuals are attracted into high-paying occupations and as firms find substitutes for exceptionally expensive workers.
52. The word "Community" in the ACS title tells us the purpose for which this survey was designed, stated explicitly on the ACS website: "Data from the American Community Survey helps your community. The information that the Census Bureau collects helps to determine how more than \$400 billion dollars

of federal funding each year is spent on infrastructure and services.”²⁹ Thus the income and population data collected by the ACS helps to allocate federal spending *at any point in time* across American Communities and was not designed to trace occupational wages *over time* as Dr. Murphy has done.

A. The ACS Data Suffer from Critical Measurement Errors That Make Them Unsuitable to the Analysis that Dr. Murphy Has Carried Out

1. ACS Survey Practices Create Potentially Serious Response Errors

53. One serious problem with the ACS data is that the questionnaire asks for information about all residents at the address but is filled in by only one respondent, who may or may not be the primary income earner.³⁰ This respondent is likely to provide more accurate information about his or herself than about other adults at the address.
54. Another serious problem is that the one respondent at each address is not encouraged to consult any records and most respondents presumably report from memory both for themselves and for each of the other adults.³¹ Unlike the defendants, who produced the equivalent of a check register showing what they actually paid employees, there is far less incentive for accurate reporting of these income figures by the household respondent. One incentive is to get the survey finished as quickly as possible but accuracy of the responses is not

²⁹ U.S. Census Bureau, “American Community Survey: Why should you participate?,” http://www.census.gov/acs/www/about_the_survey/why_should_you_participate/.

³⁰ U.S. Census Bureau, “The American Community Survey: 2013,” p.2, <http://www.census.gov/acs/www/Downloads/questionnaires/2013/Quest13.pdf>, “Person 1 is the person living or staying here in whose name this house or apartment is owned, being bought, or rented. If there is no such person, start with the name of any adult living or staying here.”

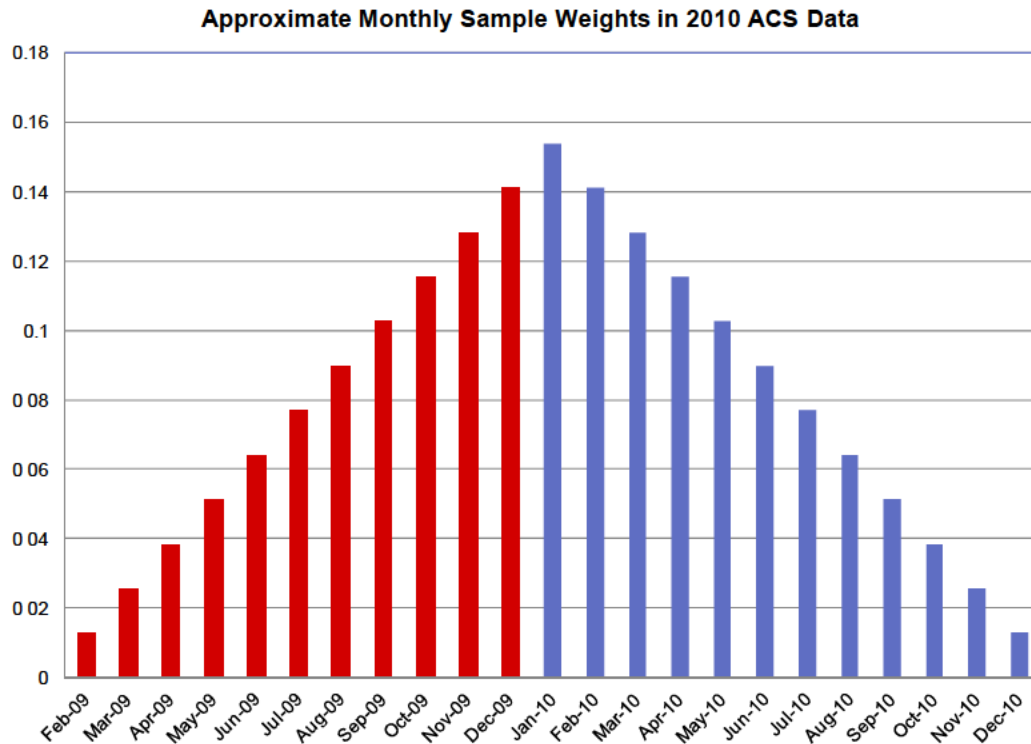
³¹ U.S. Census Bureau, “The American Community Survey: 2013,” <http://www.census.gov/acs/www/Downloads/questionnaires/2013/Quest13.pdf>, The questionnaire asks for : 1) wages, salaries, commissions, bonuses, or tips from all jobs; 2) self-employment income; 3) interest, dividends, and rental income; 4) social security; 5) welfare payments; 6) retirement; 7) other income. The income variable used in Dr. Murphy’s analysis comes from reported total pre-tax wage and salary income (i.e. money received as an employee). Sources of income include wages, salaries, commissions, cash bonuses, tips, and other income received from an employer.

monitored. Another incentive is to not tell the Federal Government anything that would bring suspicion on the household, which also encourages biased reporting.

2. The ACS Annual Data Mix Two Years of Information

55. A further and fatal problem with the ACS data is that each respondent is asked for income for each adult at the sampled address during the 365 day period ending the day when the respondent decides to complete the survey (not the previous month or the current month or the past calendar year). Respondents are unlikely to know their earnings during these unusual 365 day periods with accuracy, which contributes to the measurement error. In addition to recall error, each of these unusual 365 day reporting periods (except the ones ending on December 31) includes days from two adjacent years. For example, when a respondent reports income for the year ending on April 1, 2010, the Census Bureau makes no attempt to apportion the total between the two years to which the total applies, 2010 and 2009. Instead, the 2010 income figure reported by Census is an average (or sum) of the numbers collected in the 12 monthly surveys conducted during 2010. This means that the 2010 income figure is a mix of 2009 and 2010 data with the greatest emphasis at the beginning of the 2010 year, which is included in the income responses collected in each month throughout 2010. The Figure 2 below shows the approximate monthly sample weights, built on the assumption that the January 2010 survey collects data from February 2009 through January 2010.³² This anomaly occurs throughout all years of the data.

³² The triangular shape of this figure is something that Dr. Murphy acknowledges in his deposition. Deposition of Kevin Murphy Vol. 2, July 5, 2013 at p. 546:8:14.

Figure 2

56. This strange turn-of-the-year emphasis in the annual data affects the interpretation of any dynamic models estimated using ACS data. More importantly, it destroys the validity of any models that mix the ACS data with other series that do not suffer from this problem, notably the calendar year GDP and calendar year national employment used by Dr. Murphy.

B. The ACS Correlations Are Much Lower Than the Title-by-Title Correlations Computed with the Defendant Payroll Data

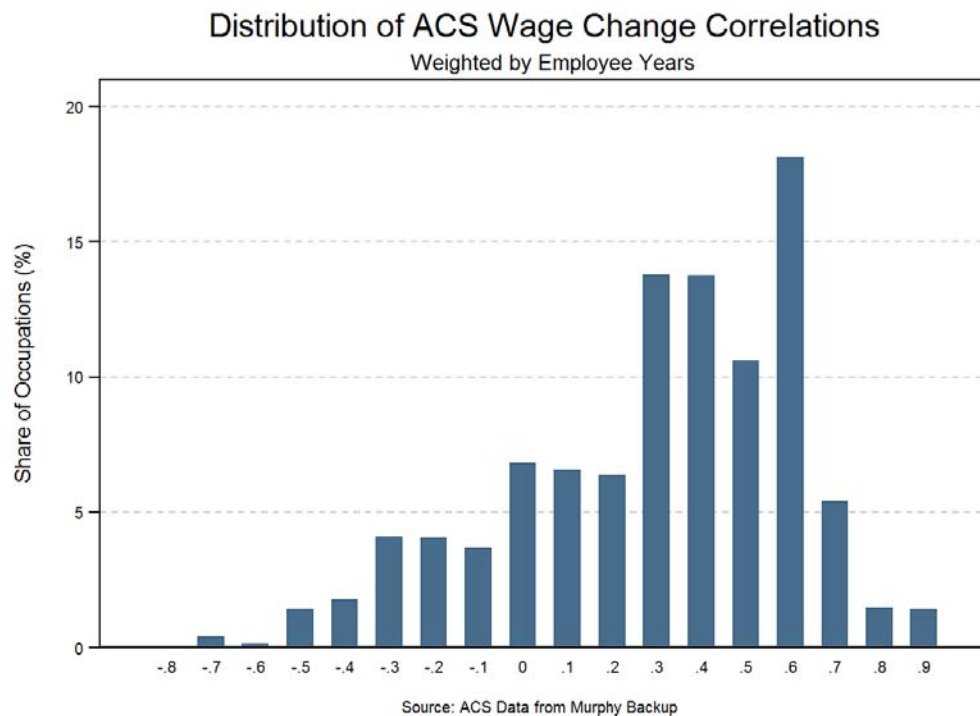
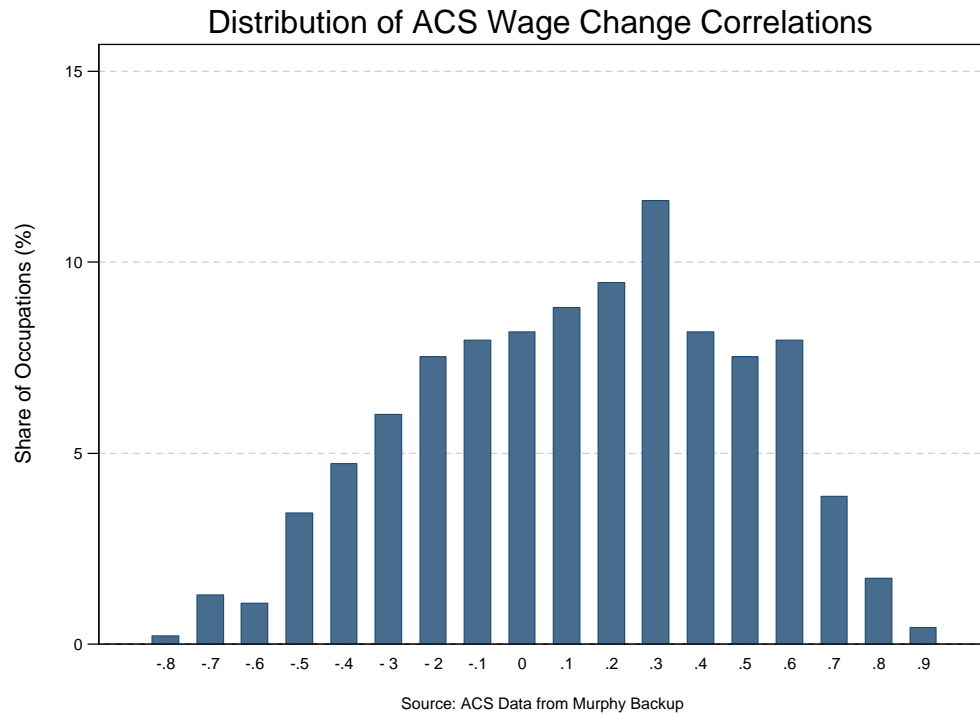
57. The first step in my study of the defendant data was to compute various correlations, title by title, and when I found them to be substantial, I sought the explanation why. When I took the same first step of computing correlations with the ACS data, I discovered that they turn out to be very small and not much in need of explanation.
58. Figure 3 illustrates the distribution of the ACS correlation coefficients between annual average wage growth in each of the 466 occupations with the growth of the average wage of the other 465 occupations collected together (“reference

wages”). This top histogram leans just slightly to the right. If all the correlations were exactly zero, the standard error would be about 0.378 based on the approximation: $(1/(n-2))^{1/2}$ and $n = 9$. What we have is a mean of 0.18 and a standard error of 0.36, which is compatible with some commonalities, but not a whole lot. The bottom chart shows the distribution of correlations weighted by the size of occupation. This chart indicates that most of Dr. Murphy’s commonality results are driven by a few large occupations.

59. I contrast these figures with analogous distribution charts constructed using defendants’ payroll data. Figure 4 shows the distribution of correlations between Defendants’ title average real compensation growth and real reference compensation growth. The substantial commonality in the Defendants’ payroll data is clear. The top histogram leans heavily to the right. The mean correlation is 0.61 and the standard error is 0.37, which indicates substantial commonality. The bottom chart which shows the distribution weighted by employee years indicates that the commonality results are broad and deep. Weighted by conduct period employee years, the mean correlation is 0.82. The contrast between the weak correlations in the ACS data and the much stronger correlations in the Defendant data is further confirmation of the role that internal equity played in setting compensation levels and the extent to which Dr. Murphy’s ACS regression analysis is nonsensical.

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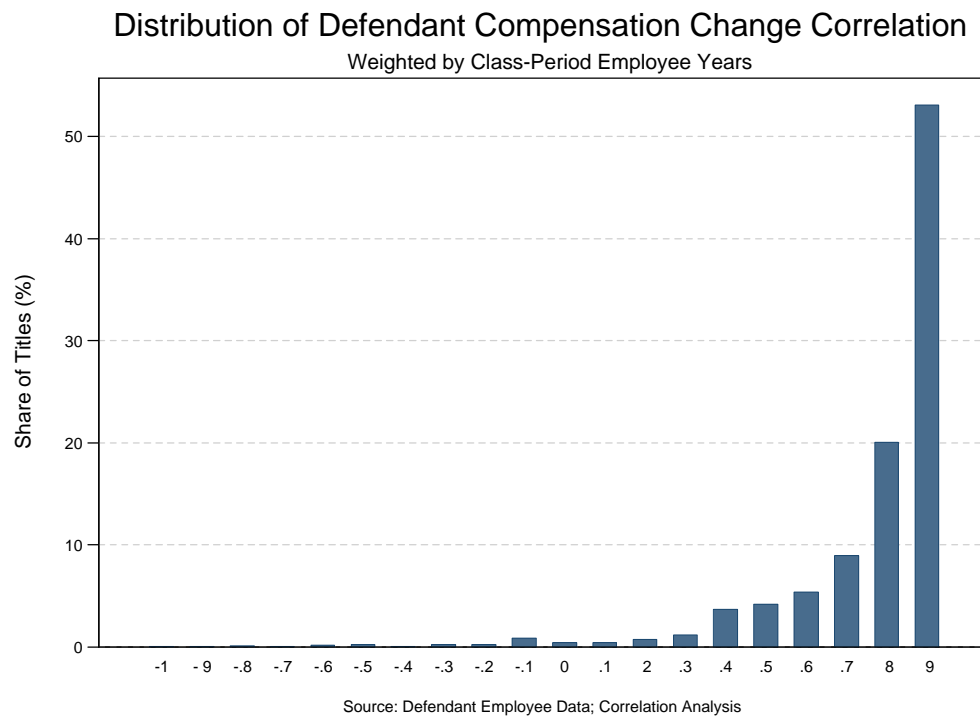
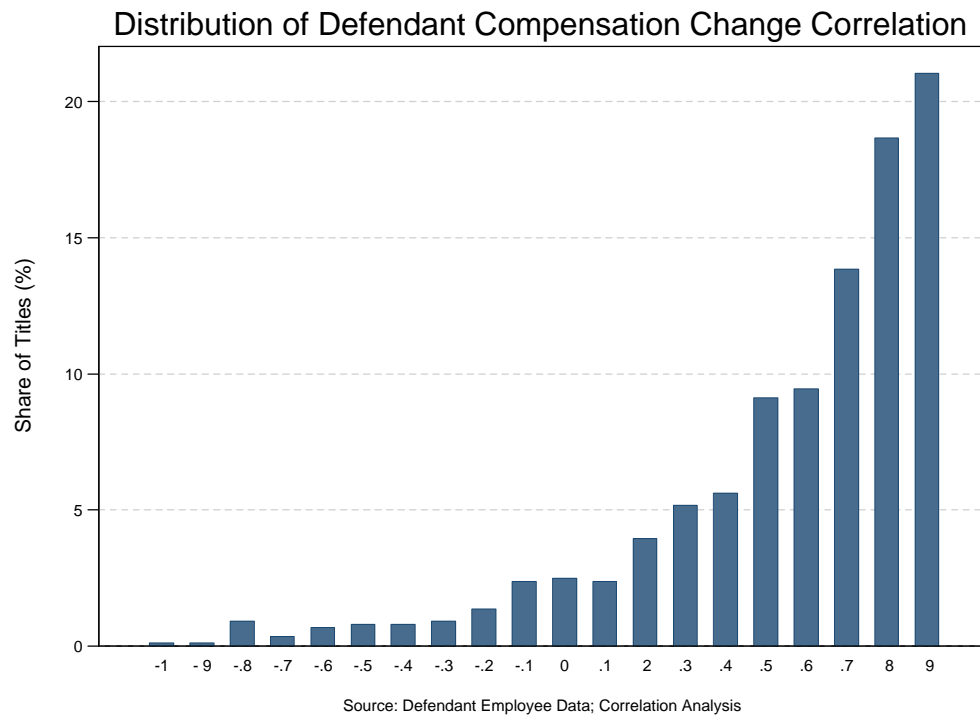
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Figure 3: Correlations of ACS Occupation Real Wage Growth with ACS Reference Wage Growth

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Figure 4: Correlations of Annual Real Growth of Defendant Title Compensation with Real Reference Compensation Growth



C. Other Flaws in the ACS Data for Dr. Murphy's Analysis

60. There are a number of additional problems with the ACS data used in Dr. Murphy's analysis. First, ACS does not allow accurate computation of "current year" dollars. The ACS annual data includes income earned in two adjacent years at two different price levels.³³ Second, the ACS survey does not collect enough information to determine in which year work occurred when the individual was not employed in every one of the preceding 52 weeks. Finally, the mapping of employment information from surveys to occupation categories (OCC codes) can be an additional source of measurement error. To identify the individual's employment category, respondents are asked to answer the question "What kind of work was this person doing?" The employment responses go through a process of classification into OCC codes, which is performed by the clerical staff trained in using the classification system.³⁴ This fuzzy mapping of respondent answers into occupations is prone to misclassification errors.

VI. Dr. Murphy's Concerns about Common Effects Excluded from My Work Are Strictly Hypothetical

61. Dr. Murphy emphasized that left-out variables can cause problems with regression analysis, but he has not put forward any specific example of such an effect. While I controlled for the external and internal non-sharing effects he claims pollute my results, he has not presented *any* analysis showing that omitted non-sharing external or internal effects are responsible for the positive sharing

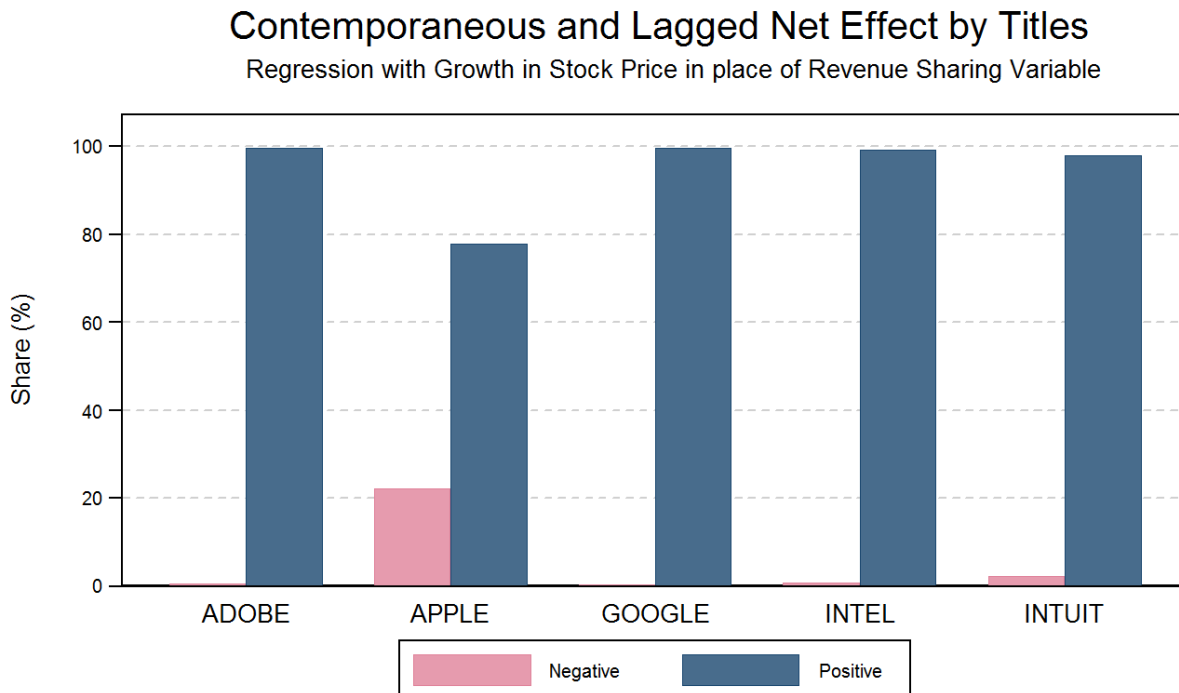
³³ "The Census Bureau provides a separate variable called ADJUST, which adjusts dollar amounts to the amount that they would have been had they been earned entirely during the calendar year. Ideally, this adjustment factor would be unique to each month of data. Consider the example of the 2008 ACS, released in the fall of 2009 but gathered throughout 2008: people surveyed in January 2008 earned all of their stated income during 2007 (January 2007 to December 2007), while people surveyed in December earned most of their stated income during 2008 (December 2007 to November 2008). However, month-specific adjustment factors would make it easier for individuals to be identified, so the Census Bureau does not provide them." Minnesota Population Center, University of Minnesota, "Note on the Standardization of ACS/PRCS Income Variables and Other Dollar Amount Variables," <https://usa.ipums.org/usa/acsincadj.shtml>.

³⁴ U.S. Census Bureau, "ACS Design and Methodology: Data Preparation and Processing for Housing Units and Group Quarters," pp 7-8, http://www.census.gov/acs/www/Downloads/survey_methodology/acs_design_methodology_ch10.pdf, "Automated coding programs were used for these items for the 2000 Decennial Census, but it was determined that using trained clerical coders would prove more efficient."

in my results. He has not elaborated on what his claimed “other common factors” could be.

62. One of Dr. Murphy’s innovations to my conduct analysis was his addition of a stock price variable (namely, the S&P 500 Index) as a common explanatory factor. He claims to use this variable regularly to check regressions. He also has said in his deposition that there may be any number of firm success factors that are not reflected in firm revenue.³⁵ Stock prices provide an indication of the market’s assessment of a firm’s future success and may contain compensation-relevant information. Thus, as a robustness check, I use each firm’s stock price data and check whether its addition to the compensation sharing regression explains away the observed co-movement. It doesn’t.

³⁵ Deposition of Kevin Murphy Vol. 1, December 3, 2012 at p. 316:11:21; Deposition of Kevin Murphy Vol. 2, July 5, 2013 at p. 485-486.

Figure 5

Source: Defendant Employee Compensation Data; Regression Analysis

Note: Distribution of sum of contemporaneous and lagged coefficients over estimated titles
Weighted by class-period employee years

VII. Conduct Regression

63. Dr. Murphy expresses his concern that I did not comment on his “more parsimonious model that included fewer explanatory variables but which still permitted measurement of separate Defendant-specific conduct effects.”
64. The conduct regression I presented in my original report differentiates the conduct effect across years and across defendants by including interactions of conduct with age, age squared, and the hiring variables. In his ‘parsimonious’ model, Dr. Murphy substitutes these interactions with a single conduct variable interacted with employer dummies.
65. This is just a restricted version of my model because, 1) it makes no differentiation between individuals by eliminating the age interaction, 2) it allows less employer differentiation by using a single dummy variable, and 3) it does

not capture business cycle effects as my model does via the hiring variable that reflects changes in the economic environment. Hence, it appears that Dr. Murphy's 'parsimonious' model may be a little too restrictive to do justice to the challenges presented by this data.

66. I have considered whether to add any variables and I am not aware of any I need to add at the present time. In my previous report, I discussed the logic behind my use of basic observable employee characteristics such as age, company tenure, gender, location, title, and employer along with firm-wide and economy-wide control variables. I also cited economic literature that uses similar modeling techniques.³⁶ In my Reply report, I discussed the lack of sensitivity of my findings to inclusion of alternative external control variables such as firm stock prices and to a different level of aggregation.³⁷ The work I have done so far establishes the robustness of my damages model, hence I stand by my earlier report which demonstrates a method by which class-wide damages can be computed.

VIII. Almost All Employees Received Supplemental Compensation or Salary Increases

67. I was asked to address a claim I understand that Defendants' expert Dr. Shaw has made that there may be Class members whose job performance was so poor they would not have received any increase in pay, regardless of steps the Defendants would have taken to increase pay in response to increased competition.³⁸ At her deposition, Dr. Shaw asserts individual managers "were given guidelines to give zero increases to low performers," but she says there is "no way of knowing" how many employees would fall into this category

³⁶ Leamer Report pp. 53 and 64-65. The adequacy of such variables is echoed by one of Defendants' experts, Dr. Shaw, who published an article that used an almost identical set of variables to explain the pattern of wage variability observed in a survey dataset. See Shaw, Kathryn L., "Wage Variability in the 1970s: Sectoral Shifts or Cyclical Sensitivity?" *The Review of Economics and Statistics*, Vol. 71, No. 1 (Feb., 1989), pp. 26-36. Dr. Shaw builds a regression model that uses individual characteristics such as experience, tenure, marital status, race and regional dummies etc along with external control variables such as projected employment growth.

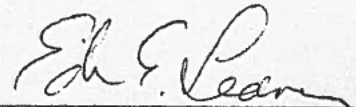
³⁷ Leamer Reply Report pp. 44-45 and 49-54.

³⁸ Expert Report of Kathryn Shaw, Ph.D., June 21, 2013.

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because the performance data does not exist to “link it up to the pay data in order to tell what those percentages are.”³⁹ Dr. Shaw also testified she has never seen, much less studied, performance data, and there are “no published peer-reviewed articles on it.”⁴⁰ However, one does not need performance data to estimate the size of the category she suggests: employees who received no salary raise or incentive pay any time during the conspiracy period. The compensation data show that 98.3 percent of Technical Class members received a salary raise or incentive pay sometime during the conspiracy period. Measured in terms of Class employee-years, the proportion is even larger: 99.8 percent. Accordingly, the proposed category is no larger than 1.7 percent of Technical Class members or 0.2 percent of Technical Class member employee-years.



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³⁹ Deposition of Kathryn Shaw, July 3, 2013 at pp. 183:8-184:21.

⁴⁰ Deposition of Kathryn Shaw, July 3, 2013 at pp. 184:24-185:10.

APPENDIX A. Defendants' Use of Salary Ranges

68. Defendants generally used target salary ranges in determining their employees' base compensation. I created charts for Defendants⁴¹ summarizing the percentage of employees in each year whose base compensation was within the Defendant's target salary range.⁴² Overall, 97 percent of employee-years in Defendants' compensation received base salary within the Defendants' target salary ranges (for the data that could be analyzed).

⁴¹ This analysis is based upon salary range data produced by Adobe, Apple, Google, and Intel. Intuit did not produce adequate data, and thus was not included in this study.

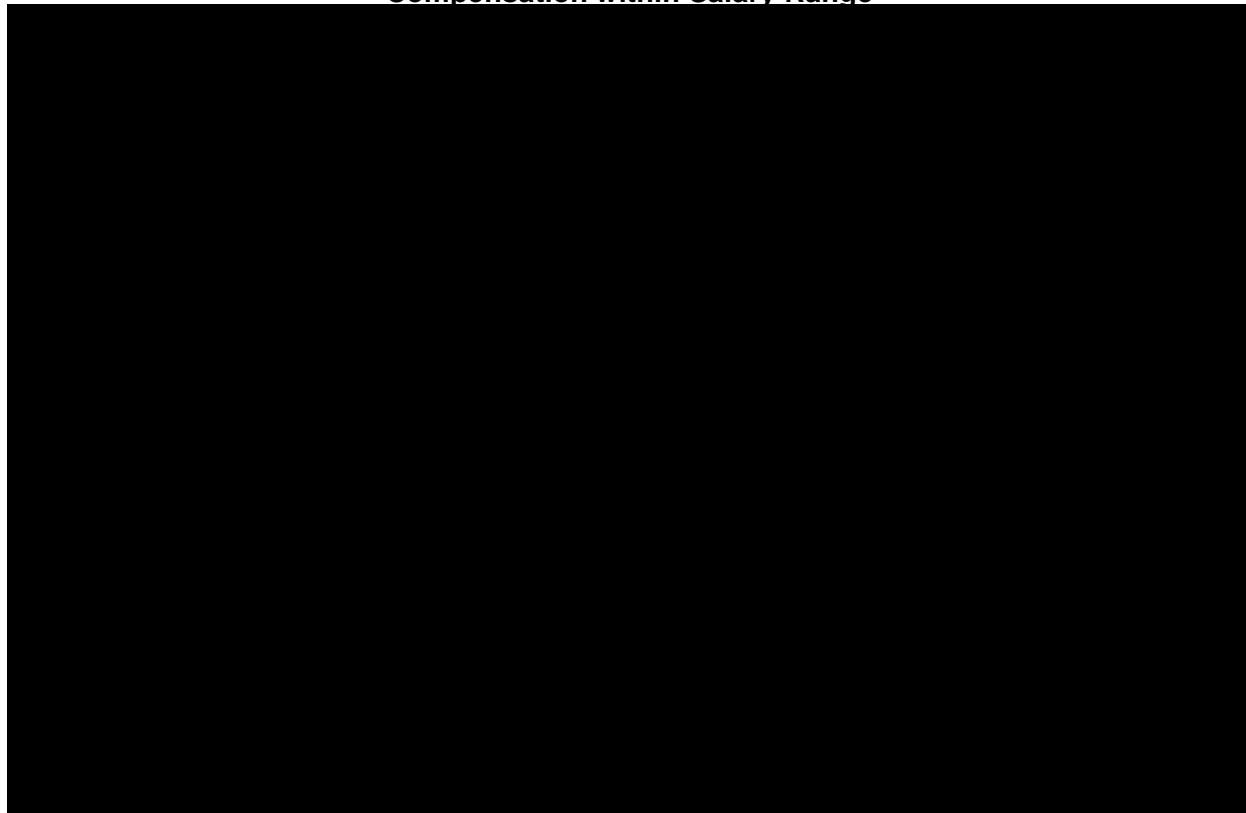
⁴² In 2007, Google started using Market Reference Points (MRPs) for each job code and location type, generally having a salary range of [REDACTED] above and below the listed MRP. See Declaration of Frank Wagner at p. 4.

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Figure 6

**Percentage of Adobe Technical Class Employees with Base
Compensation within Salary Range**

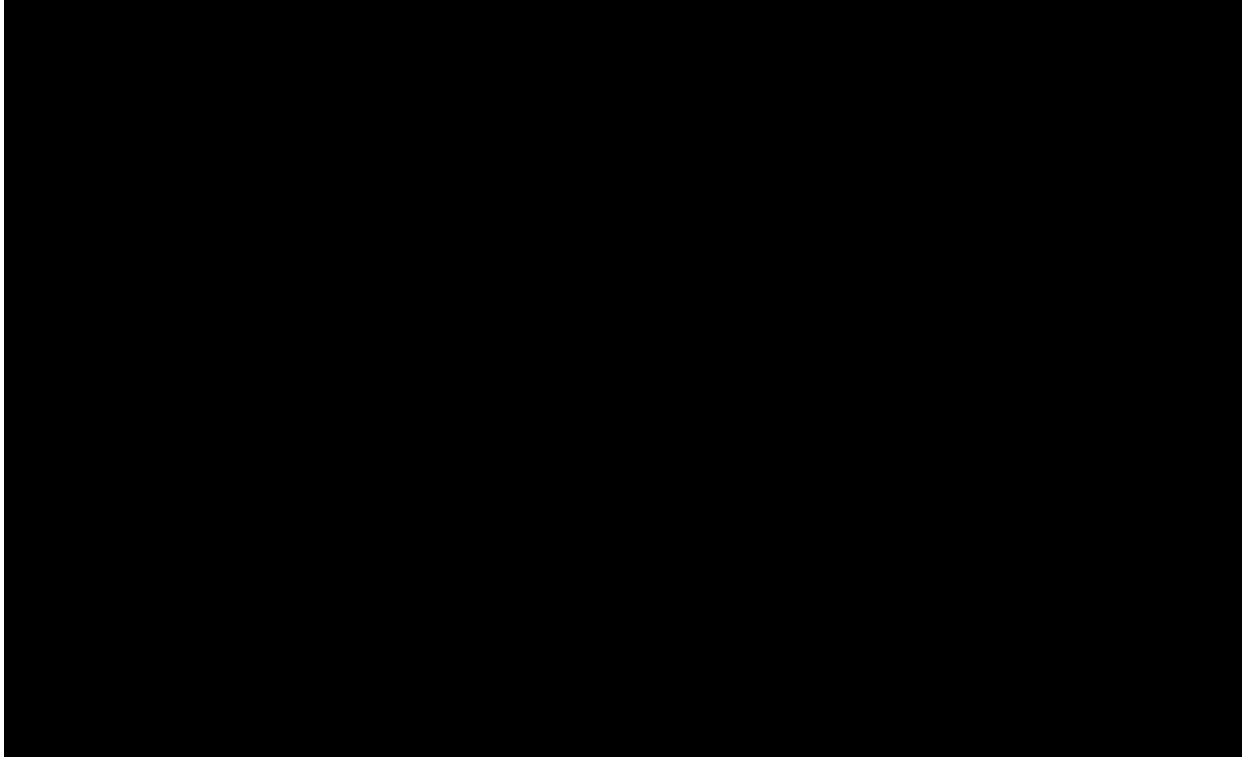


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Figure 7

**Percentage of Apple Technical Class Employees with Base
Compensation within Salary Range**



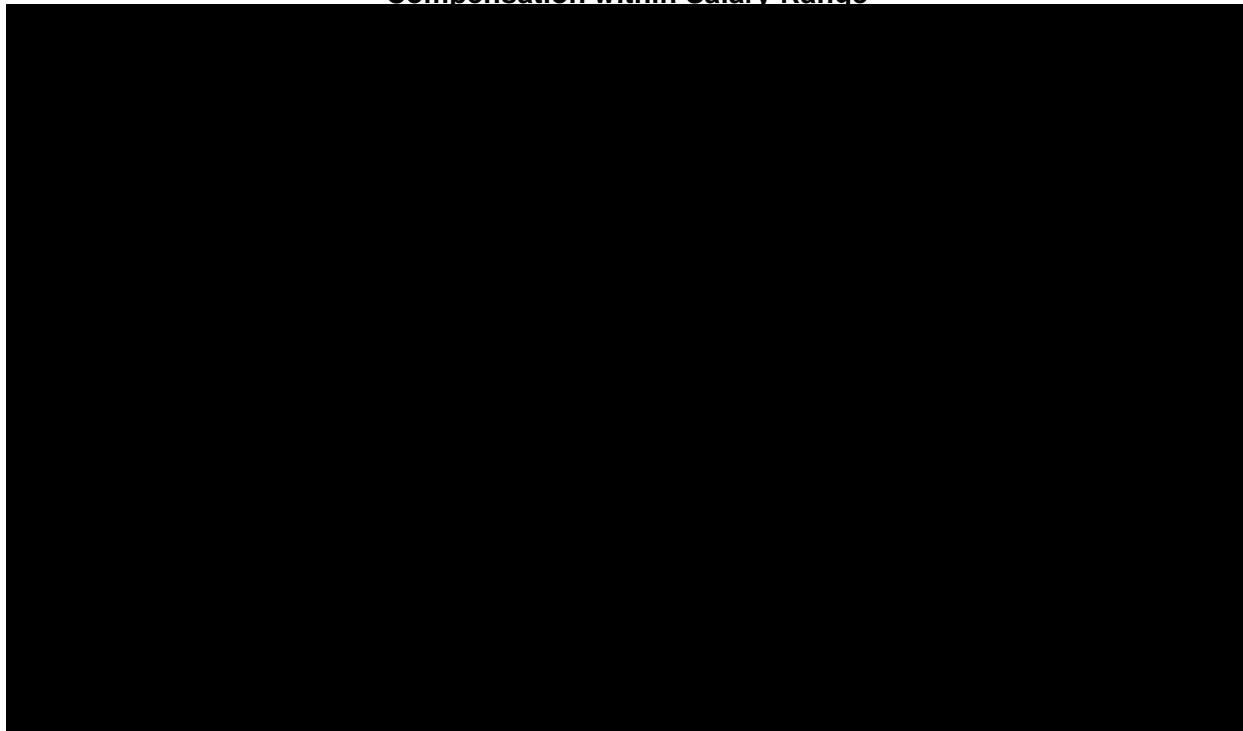
Source: 231APPLE004236, 231APPLE007258, 231APPLE008537, 231APPLE008912, 231APPLE011618,
231APPLE100713.

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Figure 8

**Percentage of Google Technical Class Employees with Base
Compensation within Salary Range**



Source: Google compensation data, GOOG-HIGH TECH-00182929, GOOG-HIGH-TECH-00395420, GOOG-HIGH-TECH-00625147, GOOG-HIGH-TECH-00625148.

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Figure 9

**Percentage of Intel Technical Class Employees with Base
Compensation within Salary Range**

